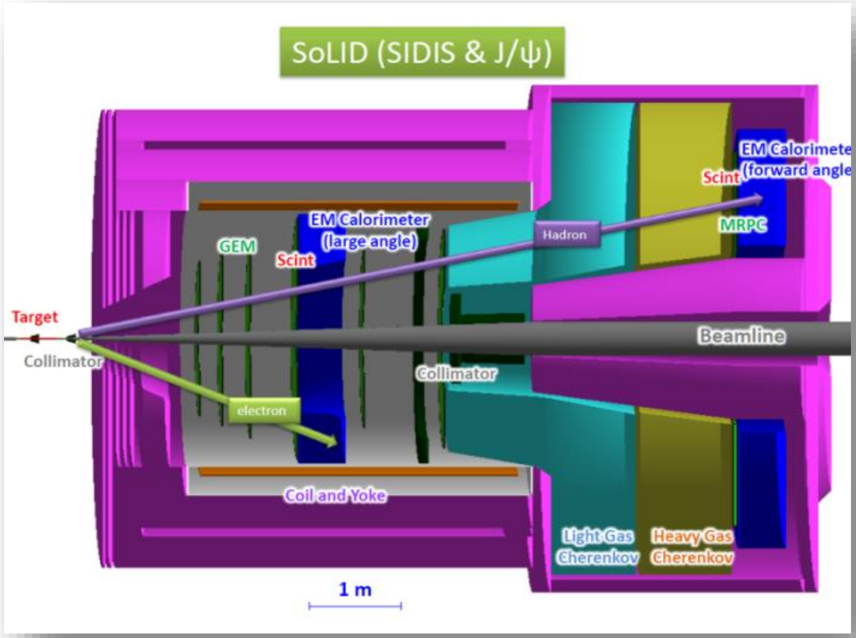
SoLID-SIDIS: Future Study of Transverse Spin, TMDs and more



Zhihong Ye

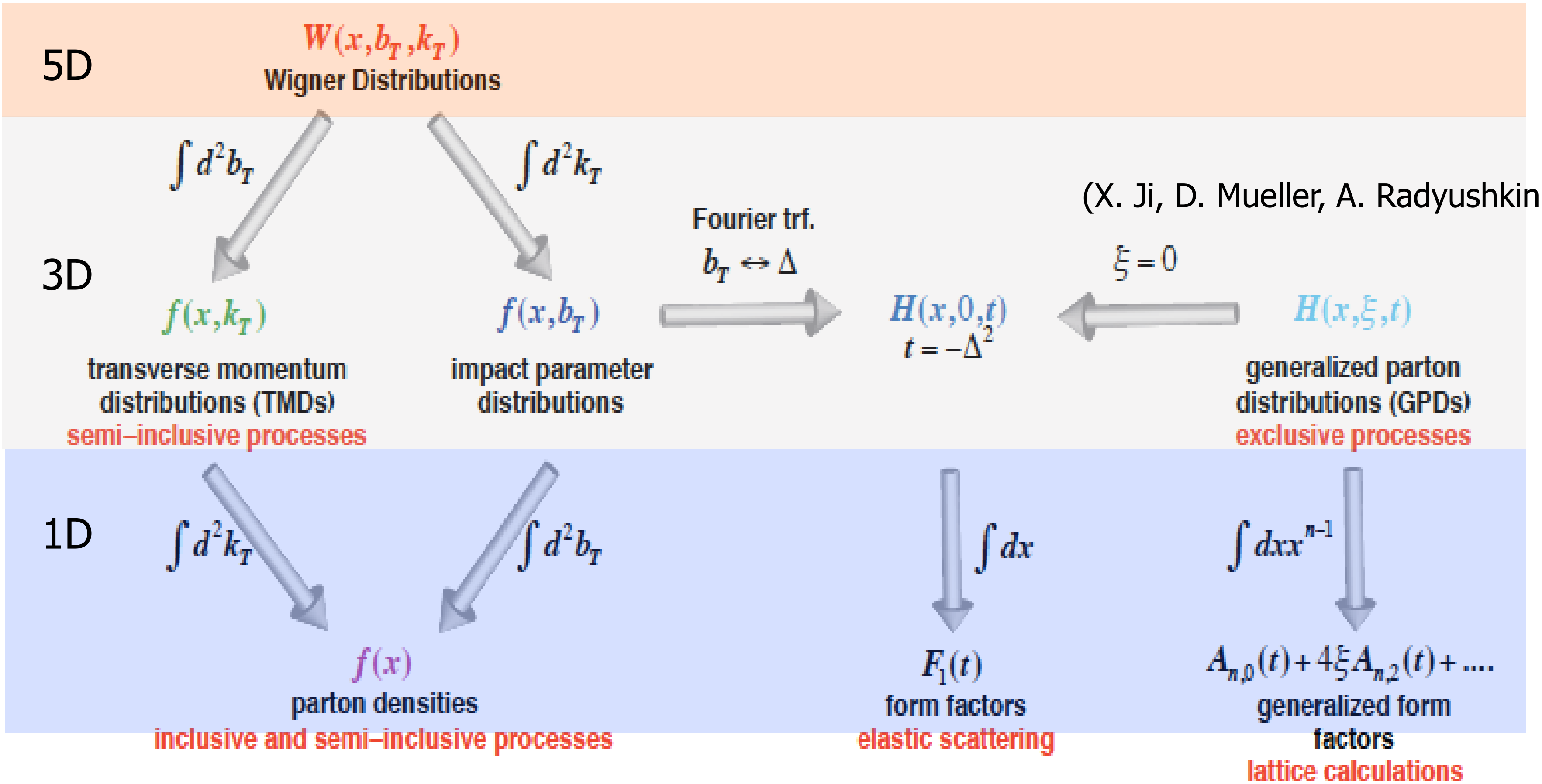
Duke University & SoLID Collaboration

DIS Workshop @ SMU, Dallas, TX

04/30/2015

Unified View of Nucleon Structure

Wigner distributions (Belitsky, Ji, Yuan) (or GTMDs)



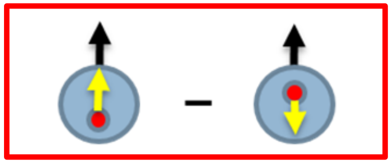
Outline

- Transverse Spin and TMDs
- Probe TMDs with SIDIS
- 6GeV SIDIS Results
- SoLID-SIDIS @ 11GeV
- GPD Study via DVCS with SoLID
- Summary

Transverse Spin

- Difference between Δq and $h_1(x)$
  - Non-relativistic

$h_1(x) = q^{\rightarrow}(x) - q^{\leftarrow}(x)$, Transversity



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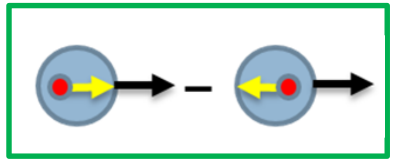
$\Delta q = q^{\uparrow}(x) - q^{\downarrow}(x)$, Helicity



$$g_1(x) = \frac{1}{2}\sum_q e_q^2 \Delta q(x).$$

  - Relativistic: Lorentz boost and rotation don't commute
    - ✓ Imply the relativistic nature of the nucleon spin structure
    - ✓ Exist of orbital angular momentum of quarks

- Hard to access in Inclusive DIS process: $g_2 \sim (m_q/M)h_1(x) + \ldots$ OPE
- Can be accessed in semi-inclusive DIS (SIDIS)
- Interesting features:
  - Valence-like behavior
  - Soffer's inequality: $|h_1(x)| < \frac{1}{2}(f(x) + \Delta q(x))$
  - Chiral-odd nature etc.

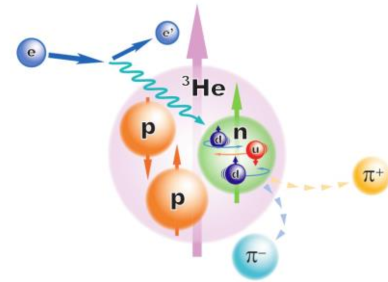
TMDs

❑ Leading-Twist TMDs

8 TMDs with different polarization direction of nucleons and quarks

Nucleon Polarization	Quark Polarization: Unpolarized (U)	Quark Polarization: Longitudinally Polarized (L)	Quark Polarization: Transversely Polarized (T)
U	$f_1(x,k_T^2)$		$h_1^\perp(x,k_T^2)$ Boer-Mulders
L		$g_1(x,k_T^2)$ Helicity	$h_{1L}^\perp(x,k_T^2)$ Long-Transversity
T	$f_1^\perp(x,k_T^2)$ Sivers	$g_{1T}(x,k_T^2)$ Trans-Helicity	$h_1(x,k_T^2)$ Transversity $h_{1T}^\perp(x,k_T^2)$ Pretzelosity

Probe TMDs with SIDIS



$$\frac{d\sigma}{dxdyd\phi_S dzd\phi_h dP_{h\perp}^2} = \frac{\alpha^2}{xyQ^2}\frac{y^2}{2(1-\varepsilon)}\cdot$$

$$\{F_{UU,T} + \ldots$$
$$+\varepsilon\cos(2\phi_h)\cdot F_{UU}^{\cos(2\phi_h)} + \ldots$$
$$+S_L[\varepsilon\sin(2\phi_h)\cdot F_{UL}^{\sin(2\phi_h)} + \ldots]$$
$$+S_T[\varepsilon\sin(\phi_h+\phi_S)\cdot F_{UT}^{\sin(\phi_h+\phi_S)}$$
$$+\sin(\phi_h-\phi_S)\cdot(F_{UT}^{\sin(\phi_h-\phi_S)} + \ldots)$$
$$+\varepsilon\sin(3\phi_h-\phi_S)\cdot F_{UT}^{\sin(3\phi_h-\phi_S)} + \ldots]$$
$$+S_L\lambda_e[\sqrt{1-\varepsilon^2}\cdot F_{LL} + \ldots]$$
$$+S_T\lambda_e[\sqrt{1-\varepsilon^2}\cos(\phi_h-\phi_S)\cdot F_{LT}^{\cos(\phi_h-\phi_S)} + \ldots]\}$$

Unpolarized

Polarized Target

Polarized Beam and Target

f_1 =

Boer-Mulder $h_1^\perp$ =

$h_{1L}^\perp$ =

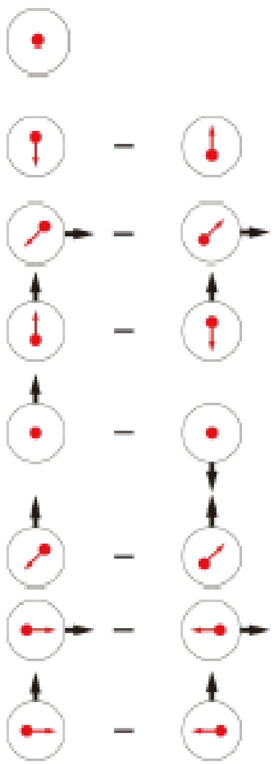
Transversity h_{1T} =

Sivers $f_{1T}^\perp$ =

Pretzelosity $h_{1T}^\perp$ =

g_1 =

$g_{1T}^\perp$ =



S_L, S_T: Target Polarization; λ_e: Beam Polarization

✓ ***TMDs can be assessed SSA/DSA in SIDIS process***

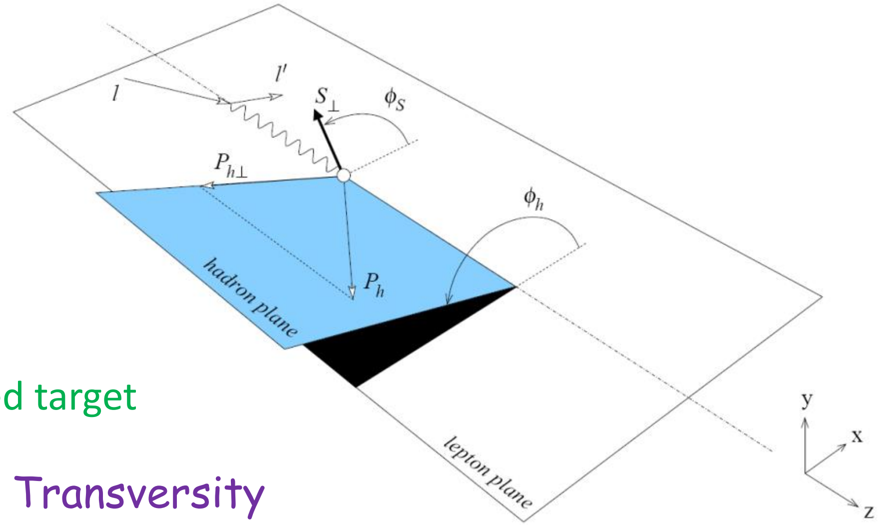
Probe TMDs with SIDIS

- Transversely polarized target Single Spin Asymmetry (SSA):
  Separation of Collins, Sivers and pretzelosity effects through azimuthal angular dependence:

$$A_{UT}(\varphi_h^l, \varphi_S^l) = \frac{1}{P}\frac{N^{\uparrow} - N^{\downarrow}}{N^{\uparrow} + N^{\downarrow}}$$

$$= A_{UT}^{Collins} \sin(\phi_h + \phi_S) + A_{UT}^{Sivers} \sin(\phi_h - \phi_S)$$

$$+ A_{UT}^{Pretzelosity} \sin(3\phi_h - \phi_S)$$



UT: **U**npolarized beam + **T**ransversely polarized target

$$A_{UT}^{Collins} \propto \langle \sin(\phi_h + \phi_S) \rangle_{UT} \propto h_1 \otimes H_1^{\perp}$$ Transversity

$$A_{UT}^{Sivers} \propto \langle \sin(\phi_h - \phi_S) \rangle_{UT} \propto f_{1T}^{\perp} \otimes D_1$$ Sivers

+Fragmentation Functions

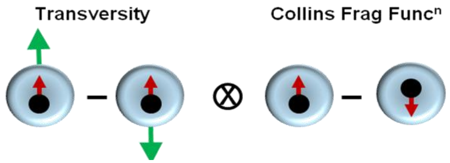
$$A_{UT}^{Pretzelosity} \propto \langle \sin(3\phi_h - \phi_S) \rangle_{UT} \propto h_{1T}^{\perp} \otimes H_1^{\perp}$$ Prezelosity

- Double-Spin Asymmetry (DSA). e.g.:

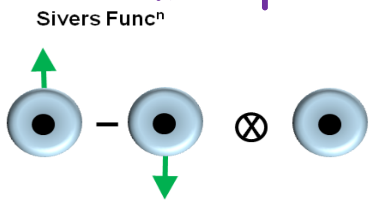
$$A_{LT}^{Worm-Gear} \propto \langle \cos(\phi_h - \phi_s) \rangle_{LT} \propto g_{1T} \otimes D_1$$ Worm-Gear

- Fragmentation functions can be obtained from (e+,e-) data

TMDs with SIDIS @ Hall-A 6-GeV

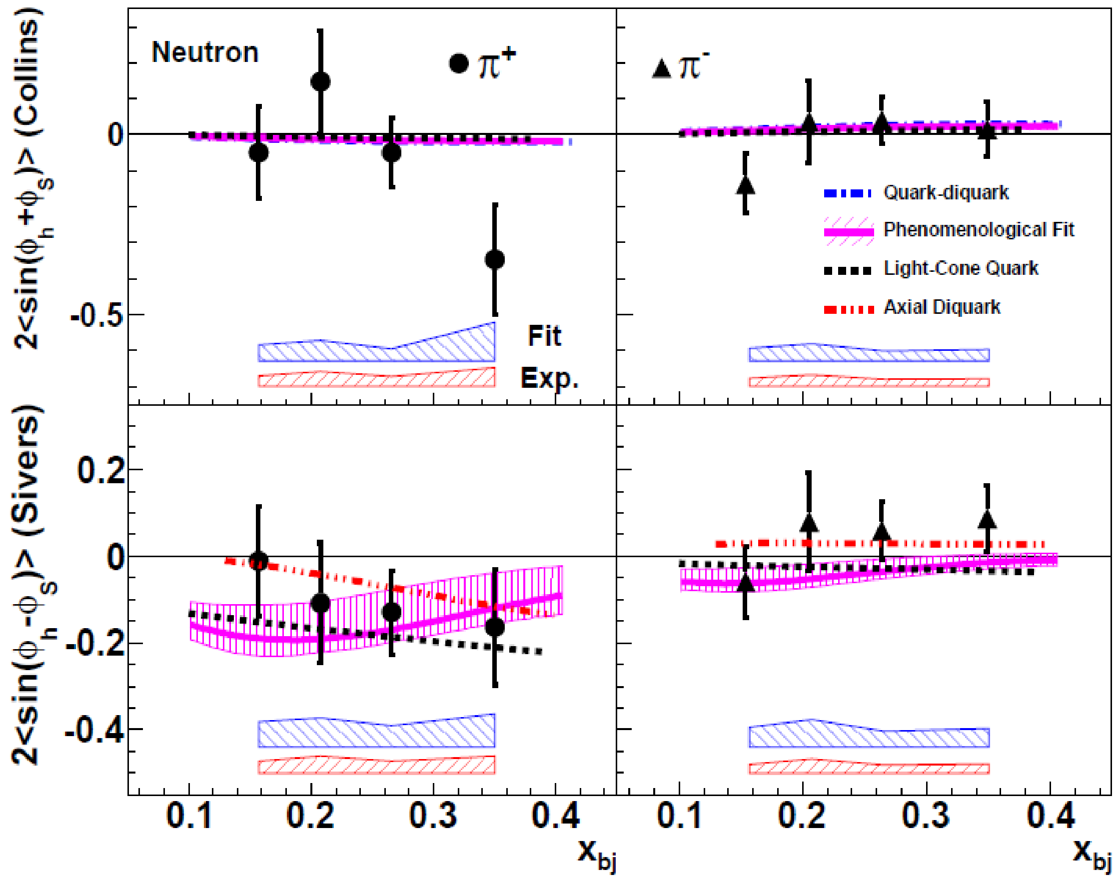


- Sizable Collins π^+ asymmetries at x=0.34?
  - Hints of violation of Soffer's inequality?
  - **Data are limited by stat. Needs more precise data!**



- Negative Sivers π^+ Asymmetry
  - Consistent with HERMES/COMPASS
  - **Independent demonstration of negative d quark Sivers function.**

X. Qian et al. (Hall A Collaboration) ***PRL 107 072003 (2011)***



Blue band: model (fitting) uncertainties
Red band: other systematic uncertainties

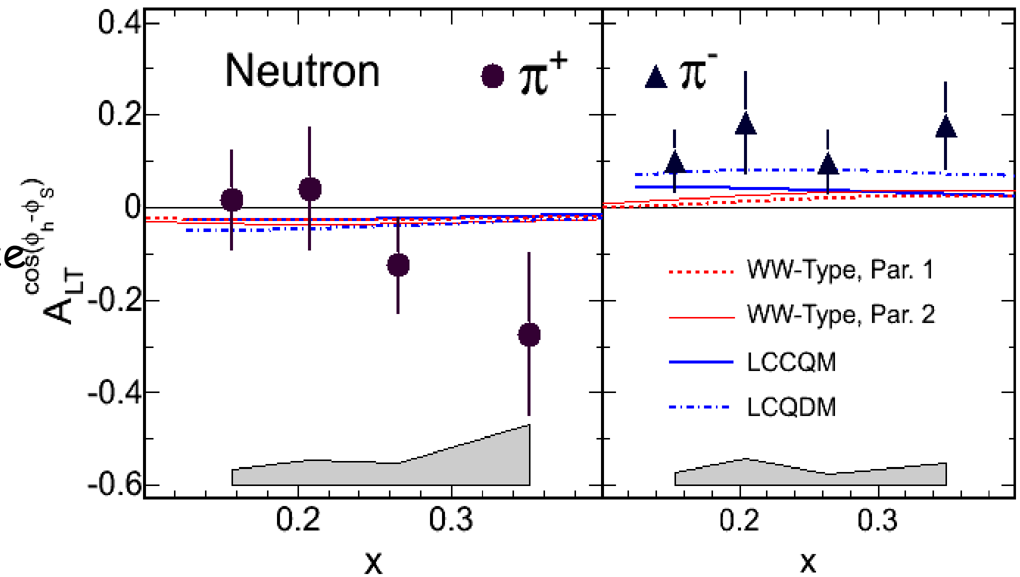
TMDs with SIDIS @ Hall-A 6-GeV

- **Worm-Gear g_{1T} Access:**

g_{1T} = 

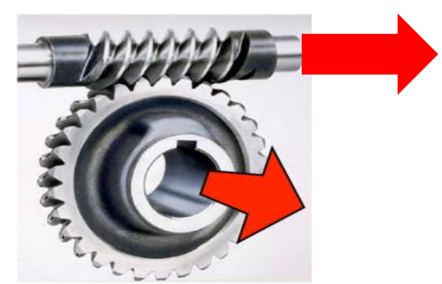
$$A_{LT}^{\cos(\phi_h-\phi_s)} \propto F_{LT}^{\cos(\phi_h-\phi_s)} \propto g_{1T}^{q} \otimes D_{1q}^{h}$$

- Dominated by real part of interference between
  L=0 (S) and L=1 (P) states
  Imaginary part -> Sivers effect
- (Measured by COMPASS and HERMES on p and D targets)



Huang, et. al. (Hall A Collaboration)
PRL. 108, 052001 (2012)

- E06-010 - First data on effectively neutron target
- Consistent with models in signs
- Suggest larger asymmetry, possible interpretations:
  - Larger quark spin-orbital interference
  - different P_T dependence
  - larger subleading-twist effects



Precision Study of TMDs with SoLID+11 GeV

- Explorations:

  HERMES, COMPASS, RHIC-spin, Jlab-6GeV,…

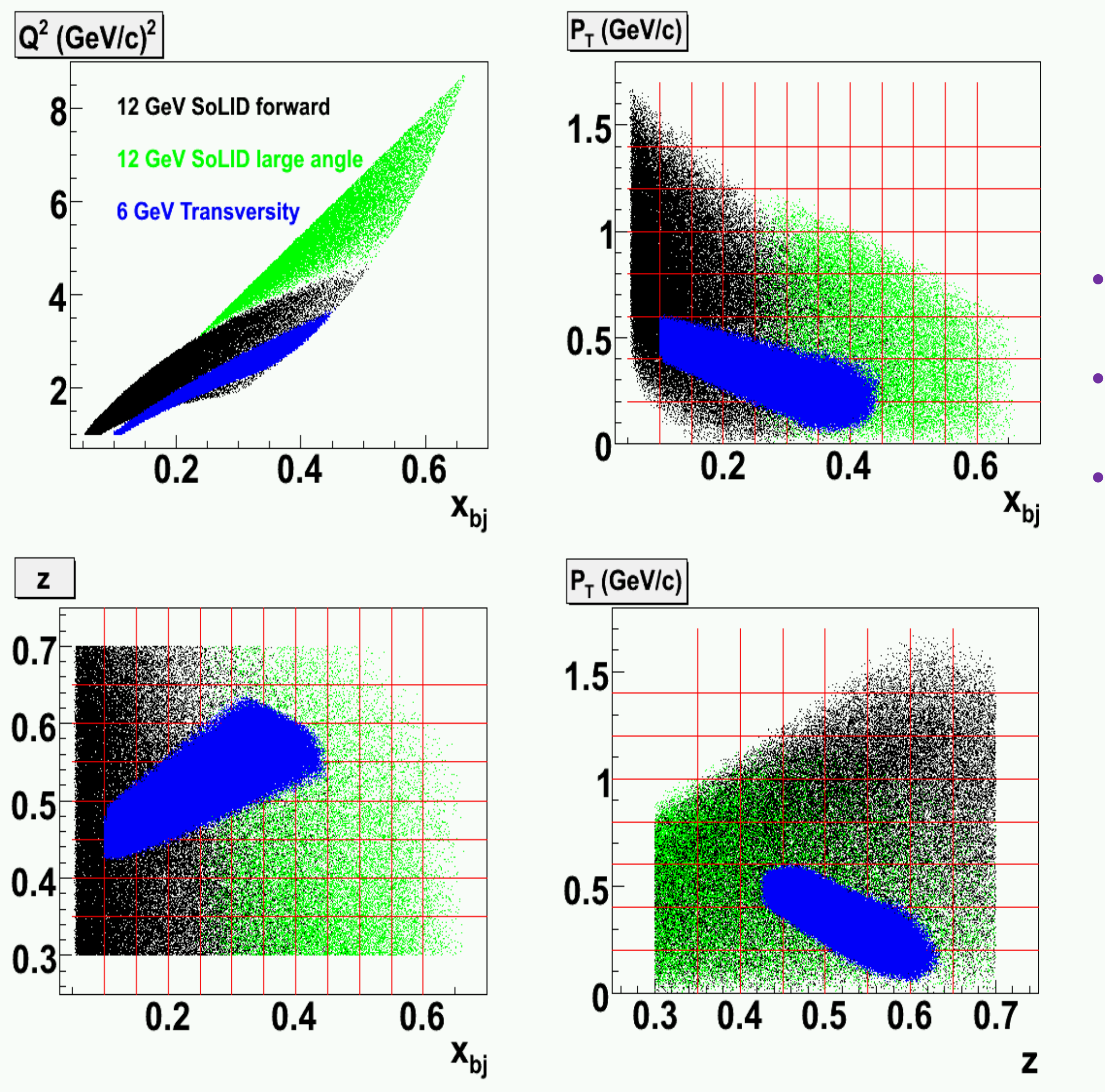
- From exploration to precision study

  JLab12: valence region; EIC: sea and gluons

  - ✓ Transversity: fundamental PDFs, tensor charge
  - ✓ TMDs: 3-d momentum structure of the nucleon
    - → information on quark orbital angular momentum
    - → information on QCD dynamics
  - ✓ Multi-dimensional mapping of TMDs

- Precision → high statistics
  - high luminosity and large acceptance ⇨ **SoLID**

SoLID-SIDIS Phase Space Coverage



- Natural extension of E06-010
- Much wider phase space
- Both transverse and longitudinal polarized target

About SoLID

- **SoLID: Solenoidal Large Intensity Device**

  High Intensity ($10^{37} \sim 10^{39}$ $cm^{-2}s^{-1}$) and Large Acceptance

- **Approved SIDIS Programs:**

  → E12-10-006 (A), SIDIS with Transversely Polarized He3, 90 days

  → E12-11-007 (A), SIDIS with Longitudinally Polarized He3, 35 days

  → E12-11-108 (A), SIDIS with Polarized Proton, 120 days

  → and bonus runs ...

- **OtherPhysics Programs:**

❖ Parity Violation Deep Inelastic Scattering (PVDIS): E12-10-007 (169 days, A)

❖ J/ψ : Near Threshold Electroproduction of J/ψ at 11 GeV: E12-12-006 (60 days, A-)

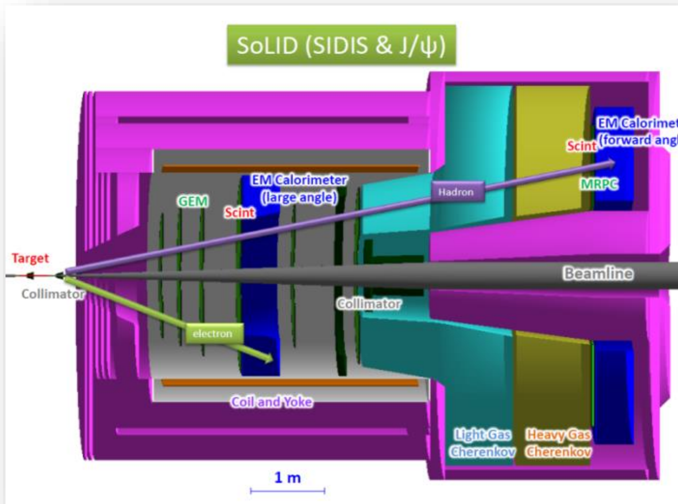
❖ *(new LOIs & Proposals)* Generalized Parton Distributions (GPDs):

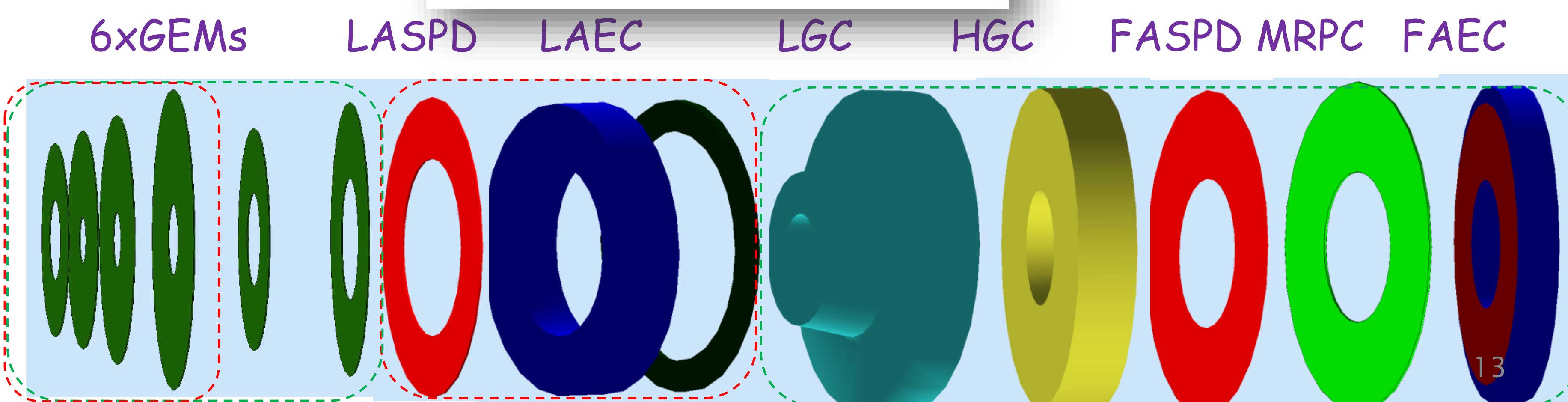
polarized-proton/neutron DVCS, Doubly DVCS, TCS, etc

❖ more

About SoLID

- High Intensity ($10^{37} \sim 10^{39}$ $cm^{-2}s^{-1}$) and Large Acceptance
- Newly developed detector techniques, fast electronics and data acquisition.
- Sophesticated MC simulation and analysis software developments

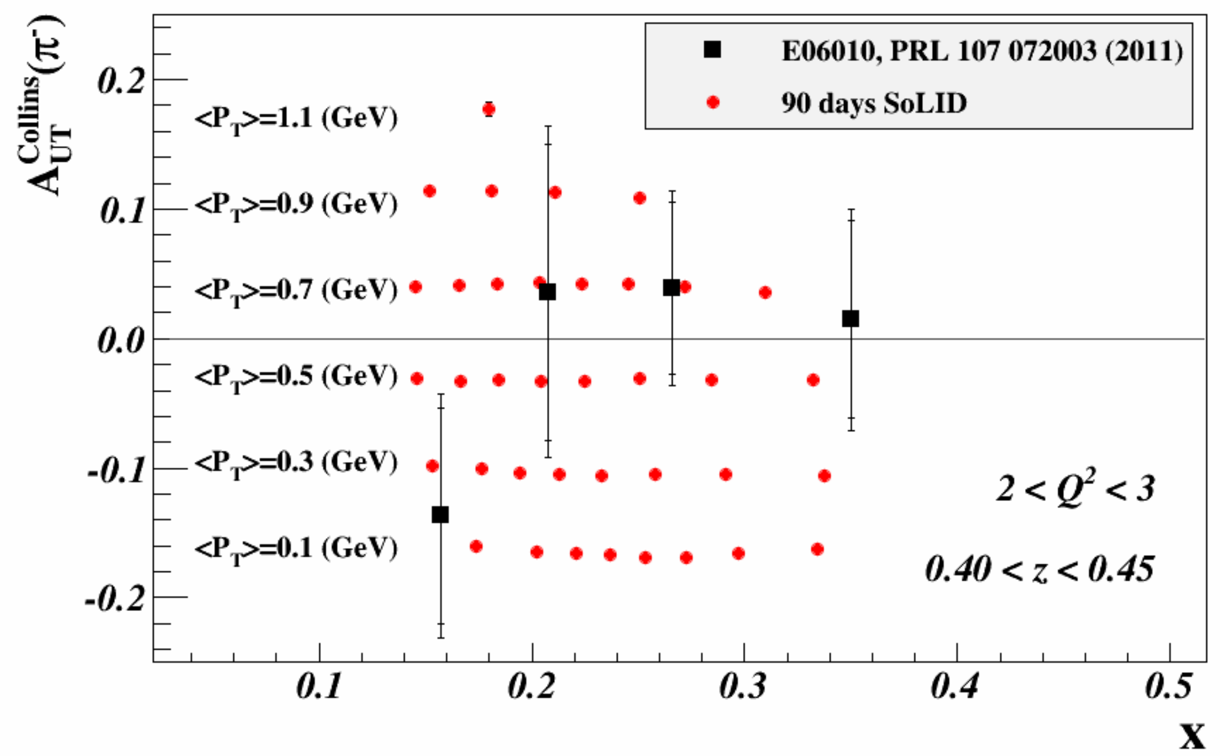




SoLID-SIDIS

- SIDIS: 4-D (x, pt, Q2, z) probe of nucleon transverse momentum distribution (TMD)
- SoLID-SIDIS studies TMDs with extensive coverage and resolutions (48 Q-z bins)

One Typical Bin to show the good statistics



> 1400 data points!

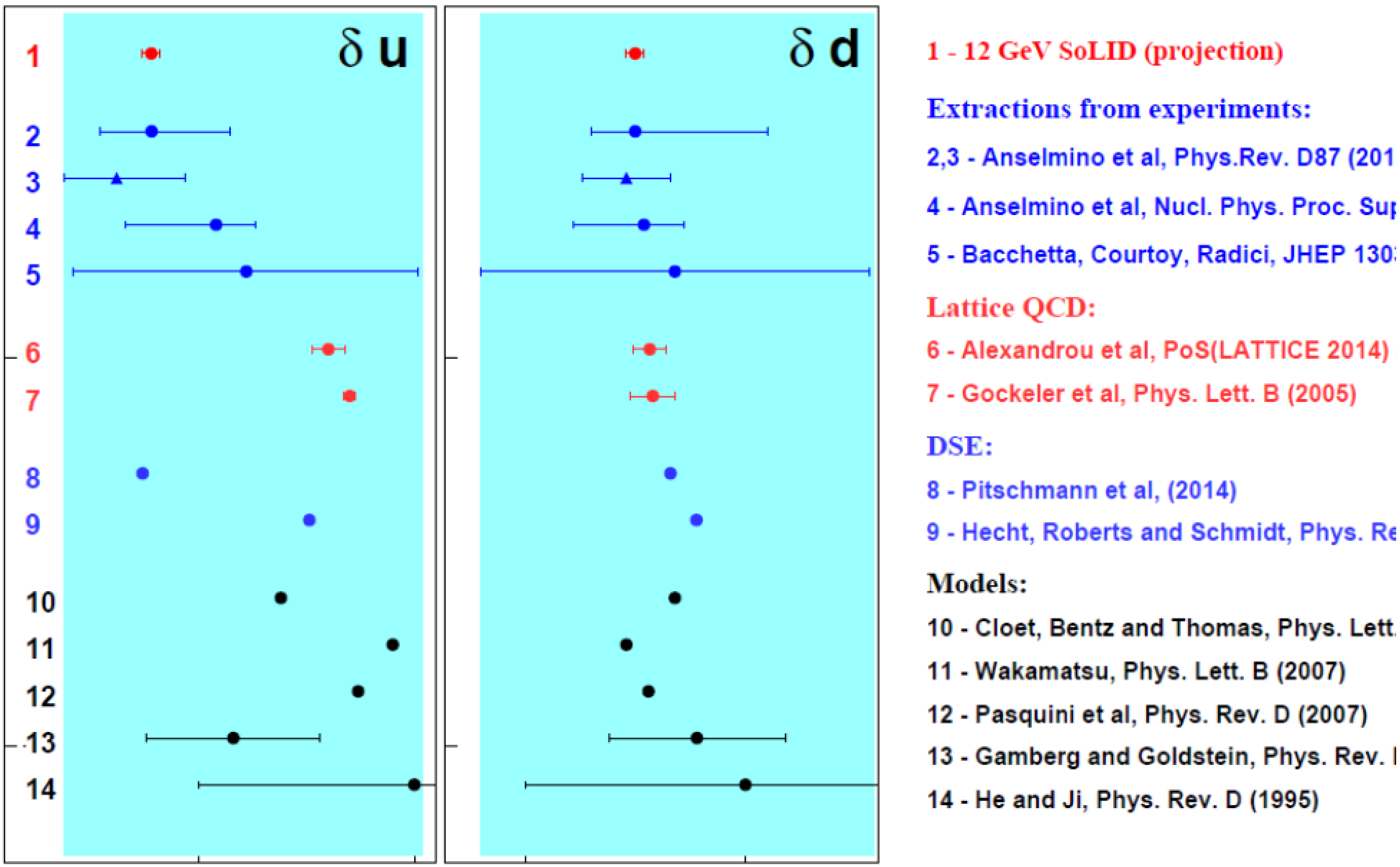
Transversity to Tensor Charge

Tensor Change: 0^{th} moment of transversity

$$\delta q = \int_0^1 dx(h_1^q(x) - h_1^{\bar{q}}(x))$$

- Fundamental quantity
- Beyond Standard model searches:

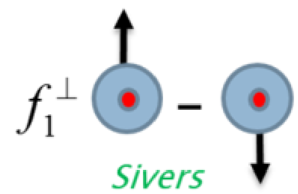
  parameters depend on precision of tensor charge

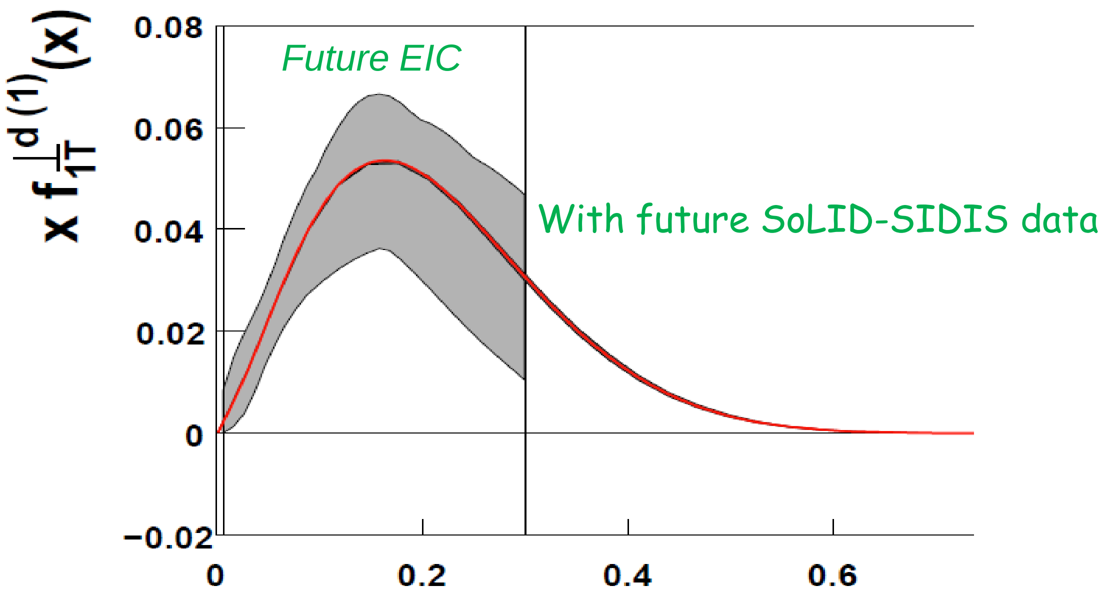


Global model fits to experiments (SIDIS and e+e-)

Sivers Function

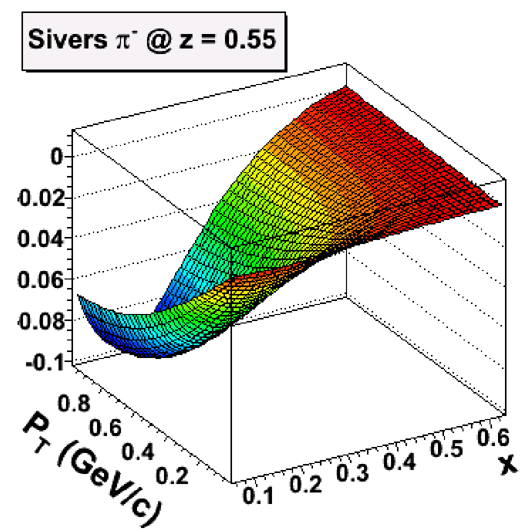
- The distribution of unpolarised parton in a transversely polarized neutron
- Sign change between SIDIS and Drell-Yan
- Significant Improvement in the valence quark (high-x) region





Illustrated in a model fit (from A. Prokudin)

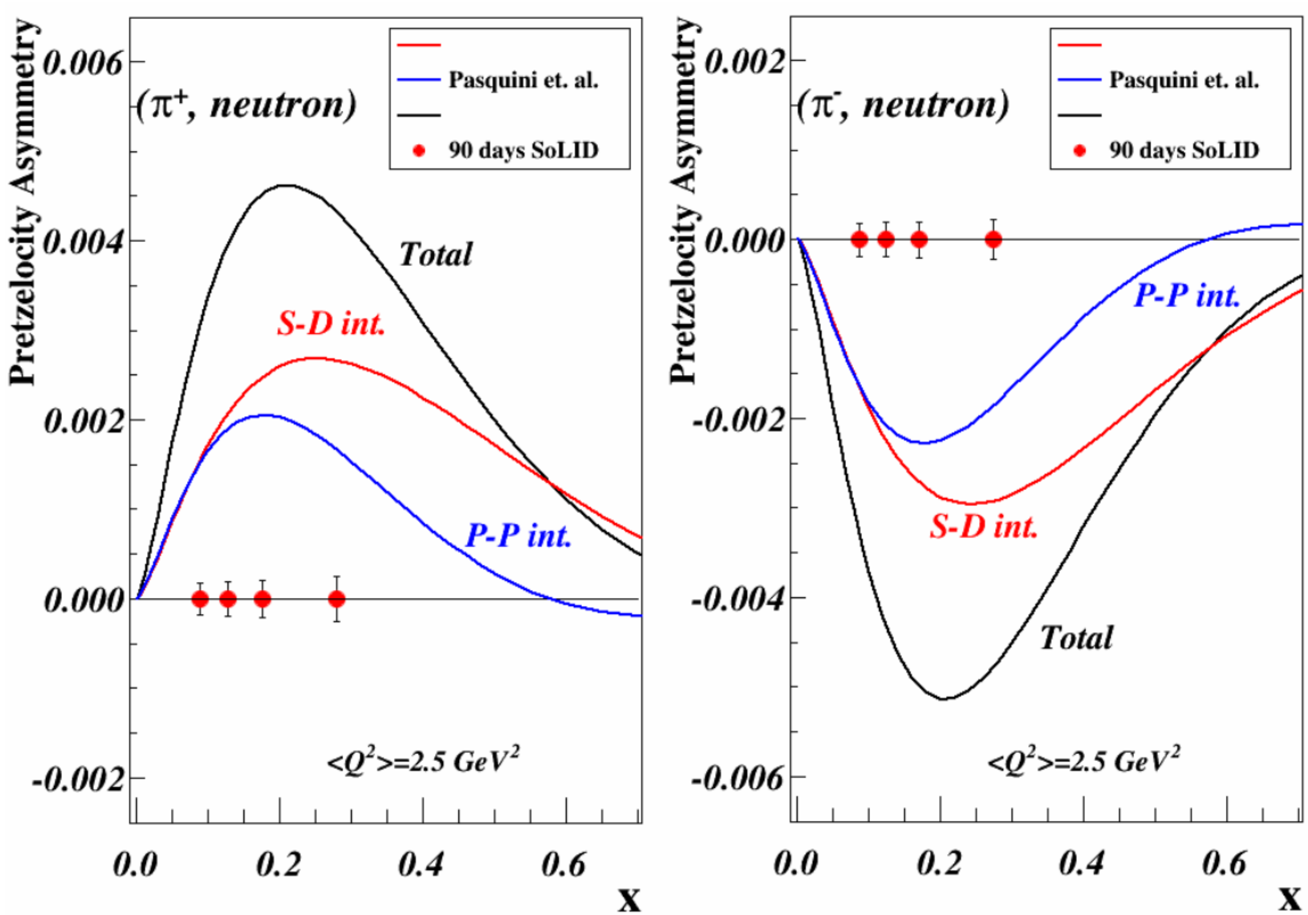
Multi Dimensional Probe



Pretzelocity & Worm-Gear

- ✓ Access the orbital angular momentum (OAM) of quarks and gluons with transverse n/p

Pretzelocity: L=0 and L=2 interference (S-D int.)
L=1 and L=-1 interference (P-P Int)
Worm-Gear: L=0 and L=1 Interference.



Quick Summary

SIDIS Summary:

- TMDs provide plentiful 3D information of the nuclear structure.
- TMDs can be probed via SIDIS on polarized targets.
- Hall-A 6GeV results showed the power of SIDIS on TMD study
- New SoLID-SIDIS experiments aims to perform 4-D precise measurements of TMDs

SoLID Summary:

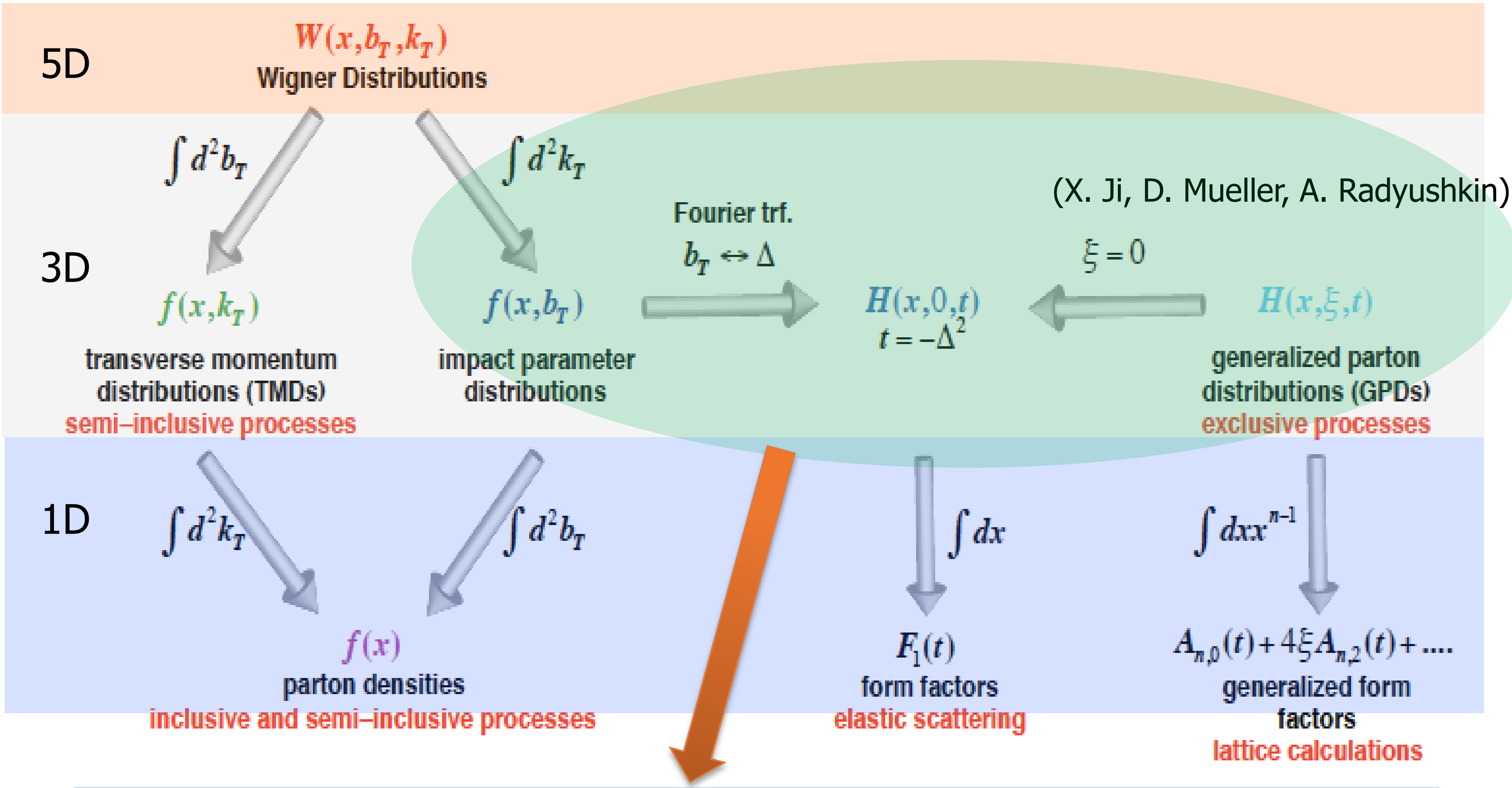
- Take advantage of latest detector and electronics techniques
- Active MC simulation, software developments and Pre-CDR & Prototyping

SoLID Timeline:

- CLEO-II magnet has been requested and will be transported in 2017
- Pre-conceptual Design Report has been submitted in 2014
- Director review in Feb. 2015
- Planning to move forward (DOE Science Review)

Unified View of Nucleon Structure

Wigner distributions (Belitsky, Ji, Yuan) (or GTMDs)



Explore GPDs in SoLID:

→ DVCS with transverse and longitudinal polarized proton and neutrons

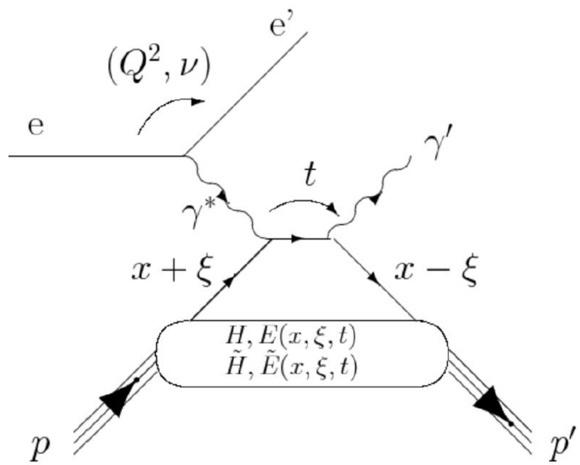
→ Doubly-DVCS, DVMP, Timelike DVCS …

GPD Study @ SoLID

- Generalized Parton Distributions (GPD):
  - Encode Information of the parton distribution in both the transverse plane and longitudinal direction.
  - Four GPDs for quarks or gluons:

$$H^{q/g}, E^{q/g}, \widetilde{H}^{q/g}, \widetilde{E}^{q/g}$$

  - Connect to FF & PDFs: e.g.



$$\int_0^1 dx H^q(x,\xi,t) = F_1^q(t)$$

$$\int_0^1 dx E^q(x,\xi,t) = F_2^q(t)$$

$$\int_0^1 dx \widetilde{H}^q(x,\xi,t) = g_A^q(t)$$

$$\int_0^1 dx \widetilde{E}^q(x,\xi,t) = g_P^q(t)$$

$$H^q(x,0,0) = q(x), x > 0$$

$$\widetilde{H}^q(x,0,0) = \Delta q(x), x > 0$$

- X → Longitudinal quark momentum fraction (not experimental accessible)
- ξ → Longitudinal momentum transfer. In Bjorken limit:

  $\xi = x_B/(2-x_B)$
- t → Total squared momentum transfer to the nucleon:

  $t = (P-P')^2$

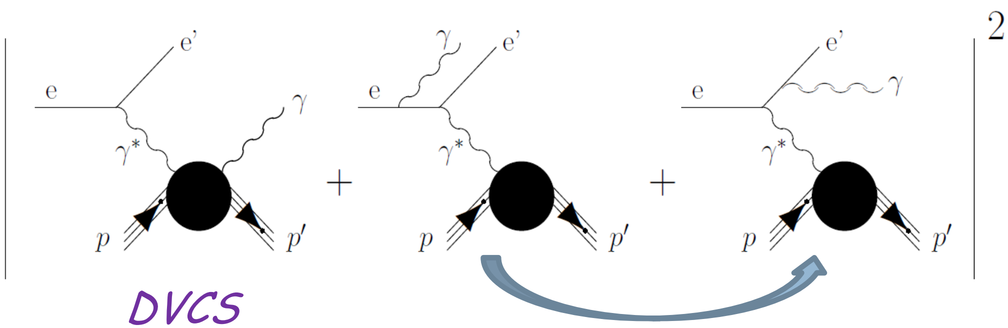
- Angular Momentum Sum Rule:

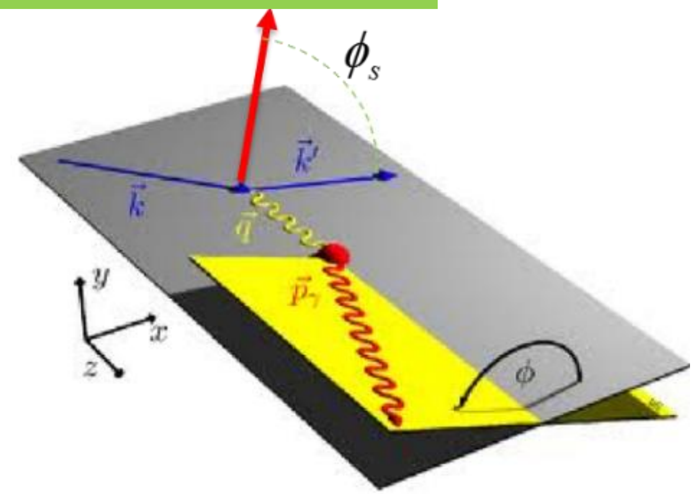
(X. Ji, PRL 78, 610 (1997))

$$J_{q/g} = \frac{1}{2}\int_{-1}^{+1} dx \cdot x[H^{q/g}(x,\xi,0) + E^{q/g}(x,\xi,0)]$$

GPD Study @ SoLID

- Deeply Virtual Compton Scattering (DVCS): $e + p/n \rightarrow e' + p/n + \gamma$





DVCS

BH

$$\frac{d\sigma}{dQ^2 dx_B dt d\phi} \propto |\tau_{DVCS}|^2 + I + |\tau_{BH}|^2$$

Interference-Term $\quad I = |\tau_{DVCS}\tau^*_{BH} + \tau^*_{DVCS}\tau_{BH}|^2$

Can access GPDs via DVCS by measuring the Φ dependence of DVCS & Interference Terms

$$\tau_{DVCS} \propto \int_{-1}^{+1} \frac{H(x,\xi,t)}{x \pm \xi \mp i\varepsilon} dx = P\int_{-1}^{+1} \frac{H(x,\xi,t)}{x \pm \xi} dx - i\pi H(\pm\xi,\xi,t),$$

$\tau_{BH} \propto$ *from Nucleon FF,* F_1 & F_2

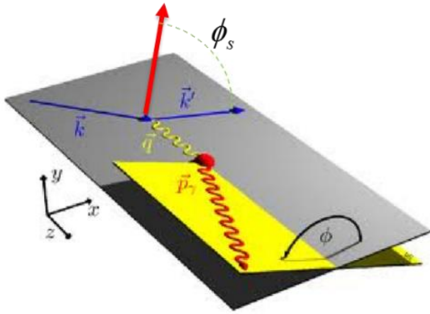
Compton Form Factor (CFF): Re($\mathcal{H}$) Im($\mathcal{H}$)

(similarly for other three)

CFFs access GPDs at x=ξ

In the asymmetry: $\quad A = \dfrac{I}{|\tau_{DVCS}|^2 + I + |\tau_{BH}|^2}$

GPD Study @ SoLID



- DVCS with polarized electron beam and targets:
  - Beam-Spin Asymmetry (longitudinal):

$$\Delta\sigma_{LU} \propto \sin\varphi \, Im\{F_1\mathcal{H} + \xi(F_1 + F_2)\widetilde{\mathcal{H}} + kF_2\mathcal{E}\}d\varphi$$

$$\begin{cases} Im\{\boldsymbol{\mathcal{H}}_{\boldsymbol{p}}, \mathcal{H}_p, \mathcal{E}_p\} \\ Im\{\boldsymbol{\mathcal{H}}_{\boldsymbol{n}}, \widetilde{\mathcal{H}}_n, \mathcal{E}_n\} \end{cases}$$

  - Longitudinal Target-Spin Asymmetry:

$$\Delta\sigma_{UL} \propto \sin\varphi \, Im\{F_1\widetilde{\mathcal{H}} + \xi(F_1 + F_2)\mathcal{H} + kF_2\mathcal{E}\}d\varphi$$

$$\begin{cases} Im\{\boldsymbol{\mathcal{H}}_{\boldsymbol{p}}, \widetilde{\boldsymbol{\mathcal{H}}}_{\boldsymbol{p}}, \} \\ Im\{\boldsymbol{\mathcal{H}}_{\boldsymbol{n}}, \mathcal{E}_n, \tilde{\mathcal{E}}_n\} \end{cases}$$

  - Longitudinal Double-Spin Asymmetry:

$$\Delta\sigma_{LL} \propto (A + B\cos\varphi)\, Re\left\{F_1\widetilde{\mathcal{H}} + \xi(F_1 + F_2)\left(\mathcal{H} + \frac{x_B}{2}\mathcal{E}\right)\right\}d\varphi$$

$$\begin{cases} Re\{\boldsymbol{\mathcal{H}}_{\boldsymbol{p}}, \widetilde{\boldsymbol{\mathcal{H}}}_{\boldsymbol{p}}, \} \\ Re\{\boldsymbol{\mathcal{H}}_{\boldsymbol{n}}, \mathcal{E}_n, \widetilde{\boldsymbol{\mathcal{E}}}_n\} \end{cases}$$

  - Transverse Target-Spin Asymmetry:

$$\Delta\sigma_{UT} \propto \sin\varphi \, Im\{k(F_2\mathcal{H} - F_1\mathcal{E}) + \ ...\}d\varphi$$

$$\begin{cases} Im\{\boldsymbol{\mathcal{H}}_{\boldsymbol{p}}, \boldsymbol{\mathcal{E}}_{\boldsymbol{p}}\} \\ Im\{\boldsymbol{\mathcal{H}}_{\boldsymbol{n}}\} \end{cases}$$

  - Transverse Double-Spin Asymmetry:

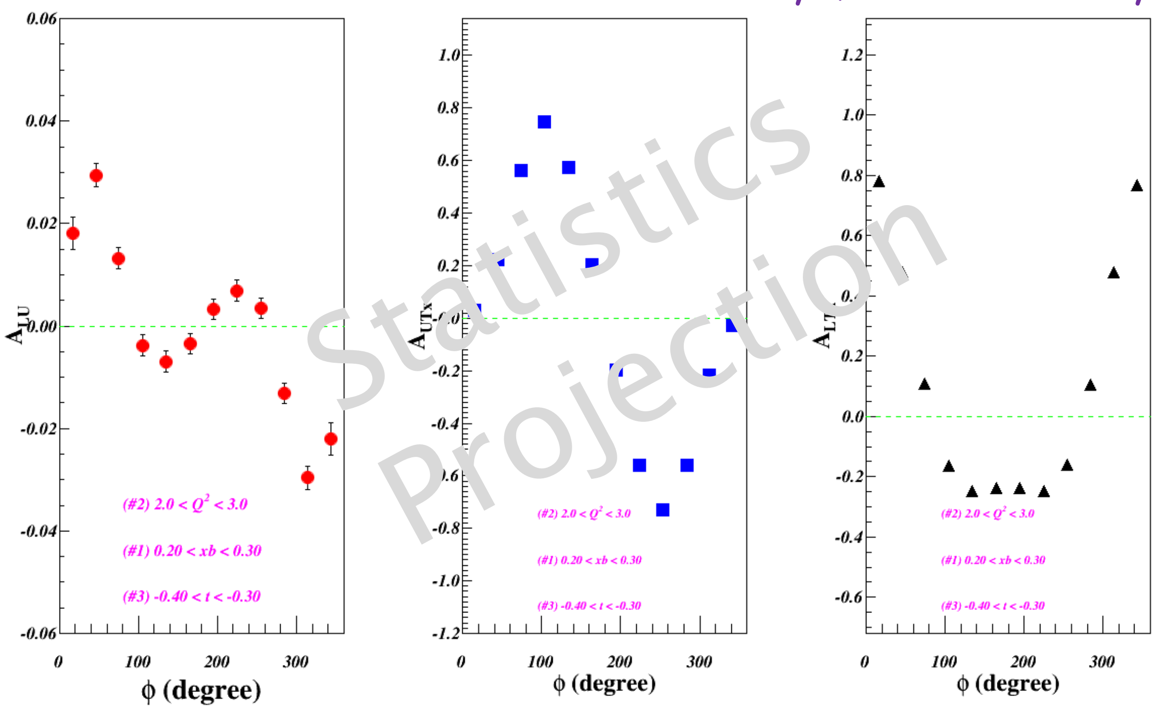
??? Needed to be added here

$$\begin{cases} Re\{\boldsymbol{\mathcal{H}}_{\boldsymbol{p}}, \boldsymbol{\mathcal{E}}_{\boldsymbol{p}}\} \\ Re\{\boldsymbol{\mathcal{H}}_{\boldsymbol{n}}\} \end{cases}$$

GPD Study @ SoLID

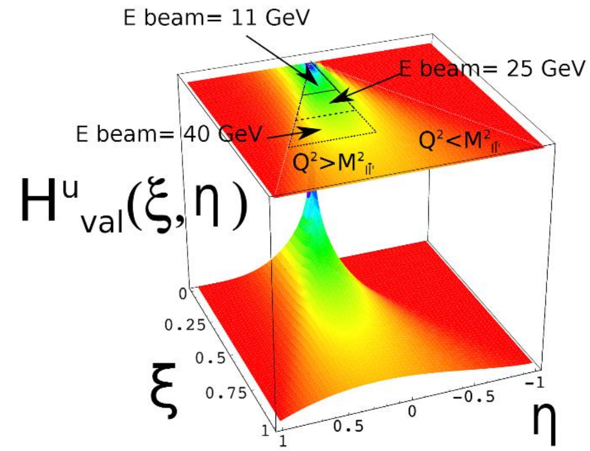
- DVCS with polarized neutron/proton with SoLID-SIDIS setup: *(new LOIs in 2015)*
  - ✓ Target Luminosity:
    1×10^{36} $cm^{-2}s^{-1}$, He3, 60% polarization (3% errors), with 15uA beam
    1×10^{35} $cm^{-2}s^{-1}$, NH3, 90% polarization (3% errors), with 100nA beam
  - ✓ Beam: 8.8 GeV and 11 GeV, Longitudinally Polarized
  - ✓ Acceptance: $1<Q^2<8$ GeV^2 , $8^o<\theta<25^o$, $0^o<\Phi<360^o$
- Asymmetry Projections: Assuming in the run group with SoLID-SIDIS

for Trans. Pol. Neutron: 11GeV ~ 48days, 8.8GeV~21days



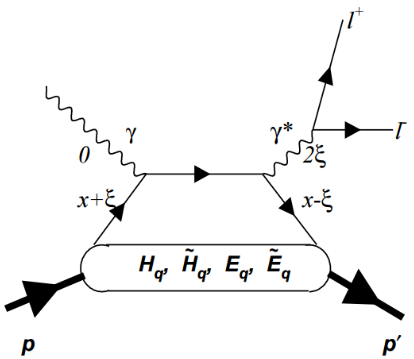
~ 100 bins in (Q2, x, t)

GPD Study @ SoLID



- Double-DVCS: $e+p/n \rightarrow e'+p/n+l^{+}+l^{-}$

✓ A lepton pair in the final state instead of a real photon
✓ Can access GPDs beyond the x=ξ limit
✓ new LOI submited to 2015-PAC and aimed for a proposal to 2016-PAC

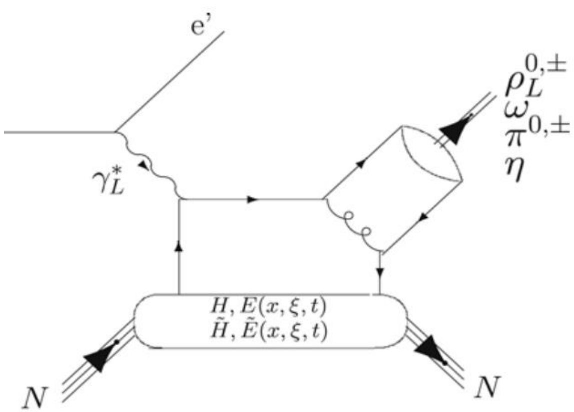


- Timelike-DVCS:

$$\gamma+p/n \rightarrow p/n+l^{+}+l^{-}$$

✓ Inverse of the space-like DVCS
✓ Extract the real part of CFFs
✓ new proposal, run with SoLID-J/Psi

- Deep Virtual Meson Production: $e+p/n \rightarrow e'+p/n+\pi^{0}/\rho^{0}/\varpi^{0}\ldots$



✓ One meson in the final state (π^0,ρ^0,ω^0, etc.)
✓ Quantum numbers probe individual GPD components more selectively than DVCS:

ρ^0/ρ + /K* $\rightarrow \mathcal{H}$, $\mathcal{E}$ (u/d), π,η,K $\rightarrow \tilde{\mathcal{H}}$ $\tilde{\mathcal{E}}$

✓ Aimed for a new proposal, run with SoLID-SIDIS

Summary

- Understanding the nucleon structure from 1D (PDFs&FF) to 3D (TMDs & GPDs)
- SIDIS provides a powerful tool to study TMDs

    8 leading twist TMDs to access quark spin & OAM, tensor change, and so on

- SoLID-SIDIS programs will perform 4D precise measurements of TMDs

    Three A rated experiments, two newly approved “bonus” experiments, and more …

- With the features of high luminosity and large acceptance, SoLID can explore a wide range of physics topics:

    SIDIS, PVDIS, J/Psi, GPD, and more …

- With the similar SoLID-SIDIS setup, we can also study GPDs via DVCS and etc.

    Three Letter-of-Intents and one proposal will be submitted in this PAC.

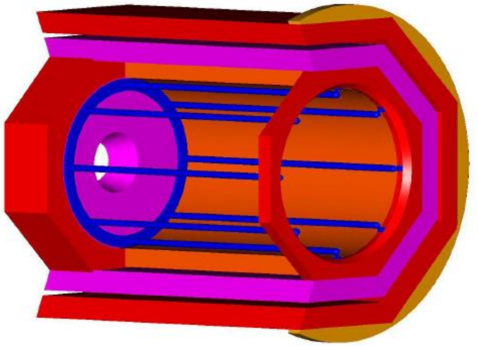
- SoLID - A strong and still expending collaboration:

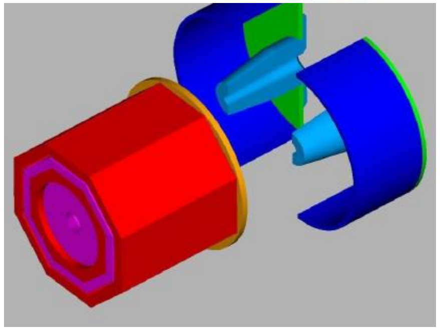
    200+ physicists, 50+ institutions and significant international contributions …

- Welcome to join the SoLID collaboration and explore more physics programs

Backup Slides

Magnet





◆ **CLEO-II Solenoid Magnet:** from Cornell Univ.

Goals:

→Acceptance: Φ: 2π, θ: 8°-24° (SIDIS), 22°-35° (PVDIS),
P: 1.0 – 7.0 GeV/c,

→ Resolution: δP/P ~ 2% (requires 0.1 mm tracking resolution)

→ Fringe field at the front end < 5 Gaus

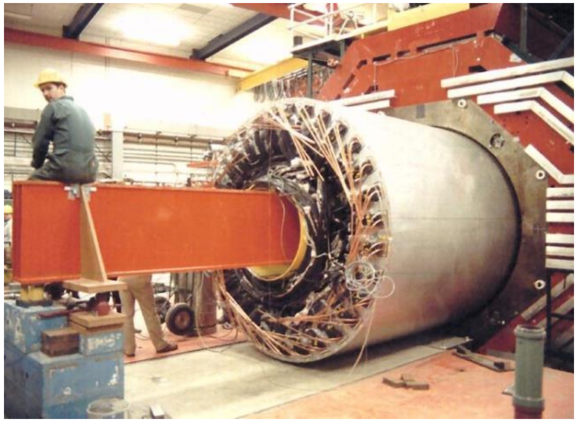
Status:

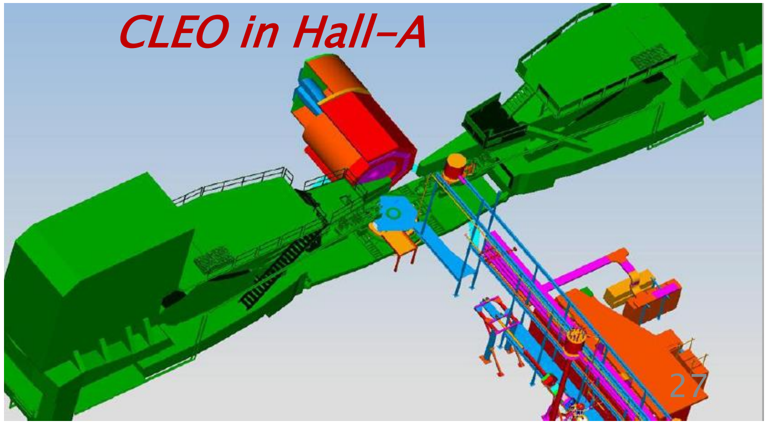
→ CLEO-II magnet formally repqested and agreed in 2013:
Built in 1989 and operated until 2008, uniform central field at 1.5 T,
Inner radius 2.9 m, coil radius 3.1 m and coil length 3.5 m

→ Site visit in 2014, disasembly in 2015 and plan transportation in 2017

→ Design of supporting structures and mounting system at JLab

CLEO at Cornell

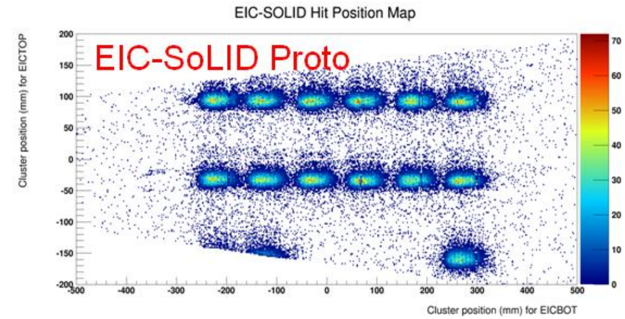




Detectors

◆ **GEM:**

→ 6 planes (SIDIS/JPsi), area~37 m^2 (165K outputs),
→work in high rate and high radiation environment.
→tracking eff.>90%, radius resolution ~ 0.1 mm,



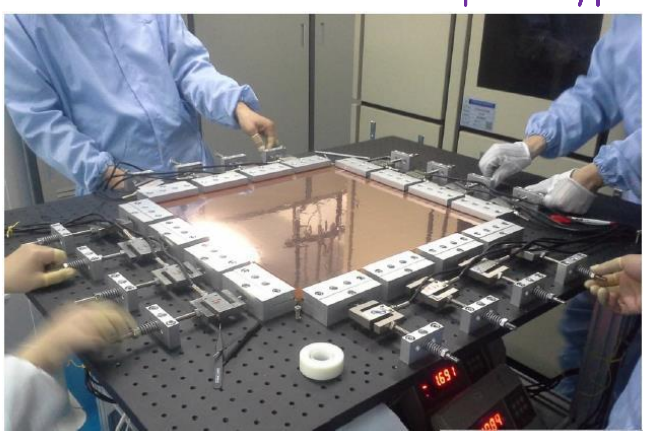
Status:

- **UVa**: First full size prototype assembled, and beam test at Fermi Lab Oct 2013

- **China**: CIAE/USTC/Tsinghua/LZU)

✓ 30x30 cm prototype constructed and readout tested, and now moving to 100cmx50cm
✓ Gem foil production facility under development at CIAE
✓ Continue on read-out electronics desgin and test

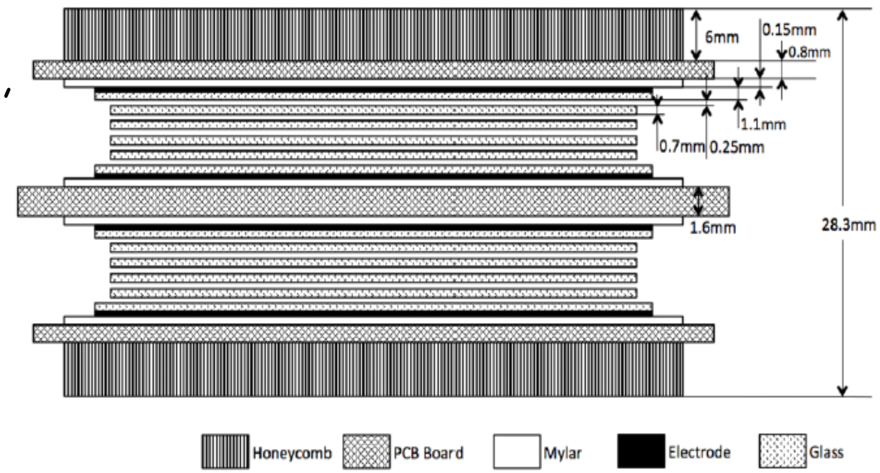
30cmx30cm GEM prototype



100cmx50cm GEM foil

Detectors

◆ **Multi-gap Resistive Plate Chamber:**



Goals:

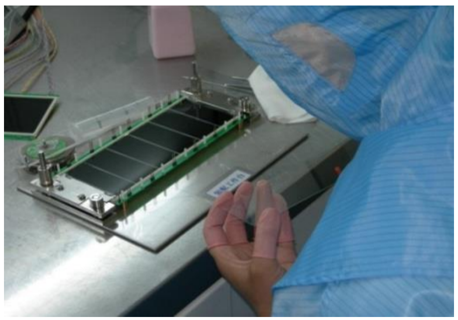
→ 50 super-modules, each contains 3 modules, 1650 strips and 3300 output channels.

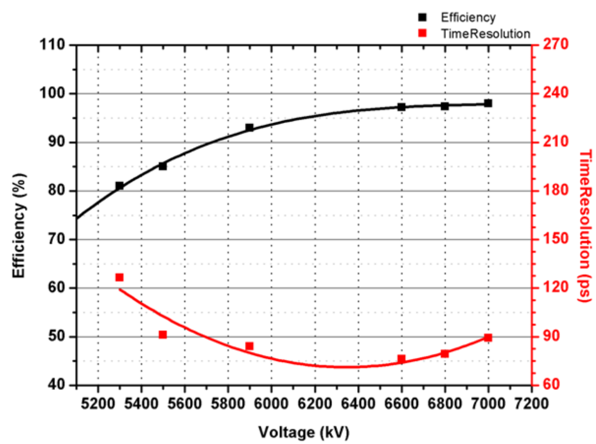
→ Timing resolution < 100ps

→ Works at high rate up to 10 KHz/cm2

→ Photon suppression > 10:1

→ π/k separation up to 2.5GeV/c





Status:

→ Prototype Developed at Tsinghua

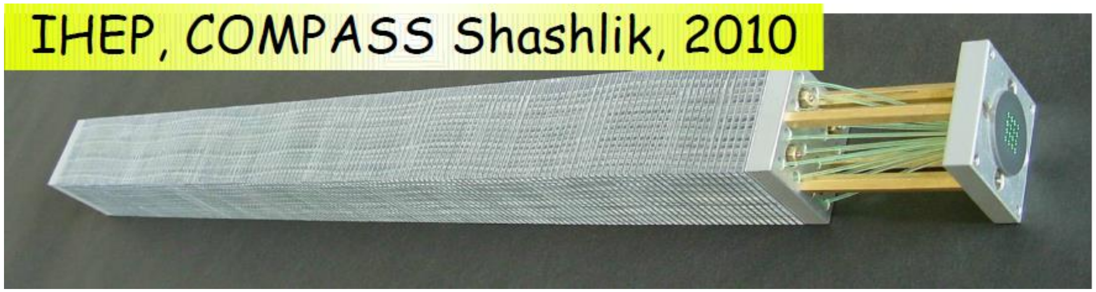
→ Beam test at Hall-A in 2012

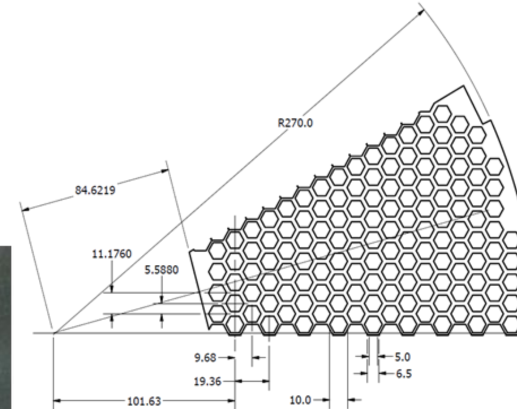
→ New facility for mass production

→ Read-out electronics design

Detectors

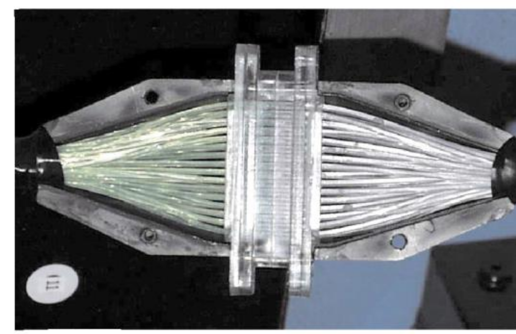
◆ **Electromagnetic Calorimeters (EC):**





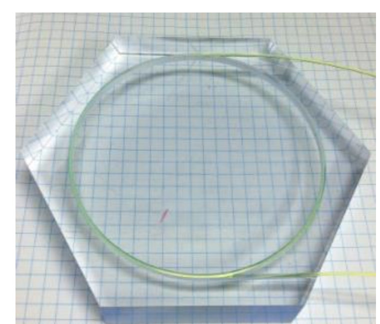
Goals:

→ Shashlyk sampling calorimeters
→ 1800 modules (2 R.L.) for PreShower, 1800 modules (18 R.L) for Shower
→ electron eff.>90%, E-Resolution~10%/√E,
  π suppresion > 50:1
→ Rad. Hard (<20% descreasing after 400K Rad)



Status:

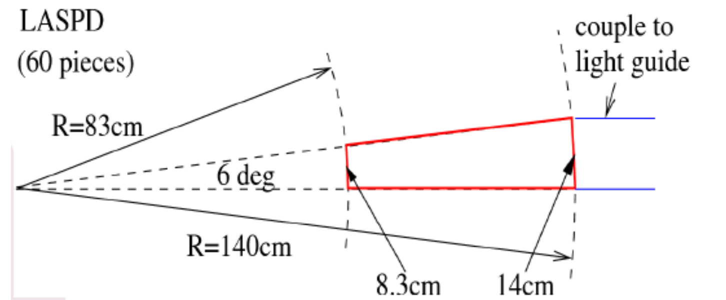
→ Sophesticated Geant Simulation
→ Active Pre-R&D at UVa and Jlab
→ Sample&PMT tests and Pre-Amp design



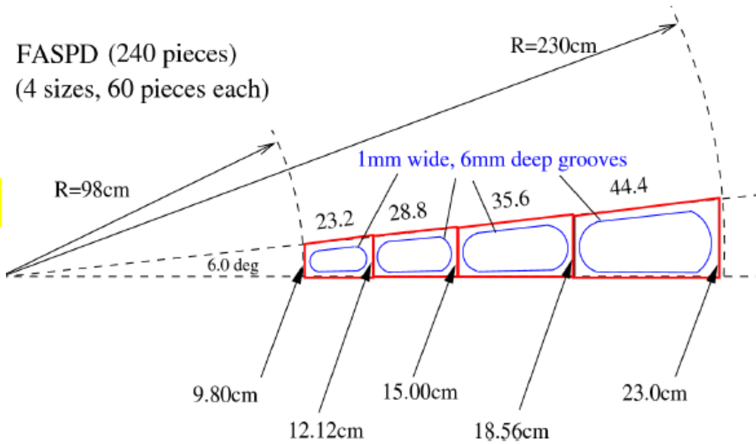
Detectors

◆ Scintillating Pedal Detectors (SPD):

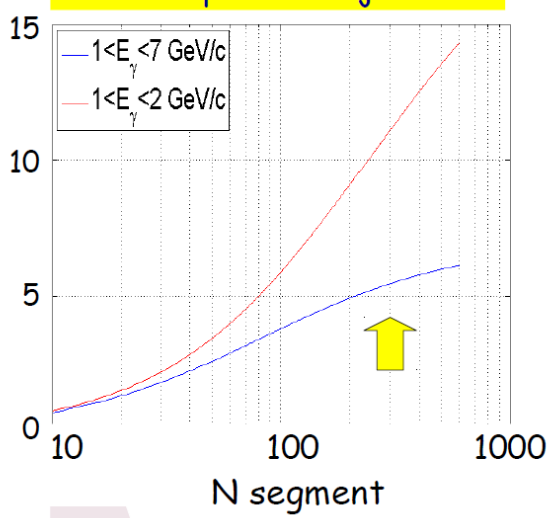
Goals:
→ For SIDIS/JPsi only
→ Two planes (in front of LAEC and FAEC):
LASPD: 60 modules, 5 mm or thicker, photon rej. 10:1
FASPD: 60 modules x 4 radius, photon rej. 5:1
→ LASPD timing resolution < 150ps



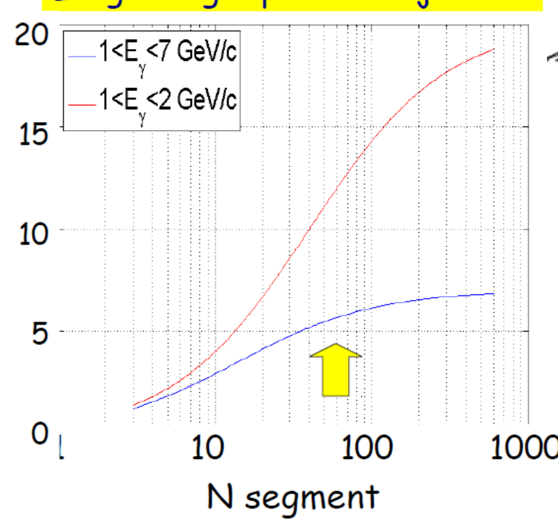
Status:
→ Design and Simulation
→ Pre-R&D at UVa and JLab



Forward photon rejection



Large-Angle photon rejection



Triggers&DAQ

◆ Triggers:

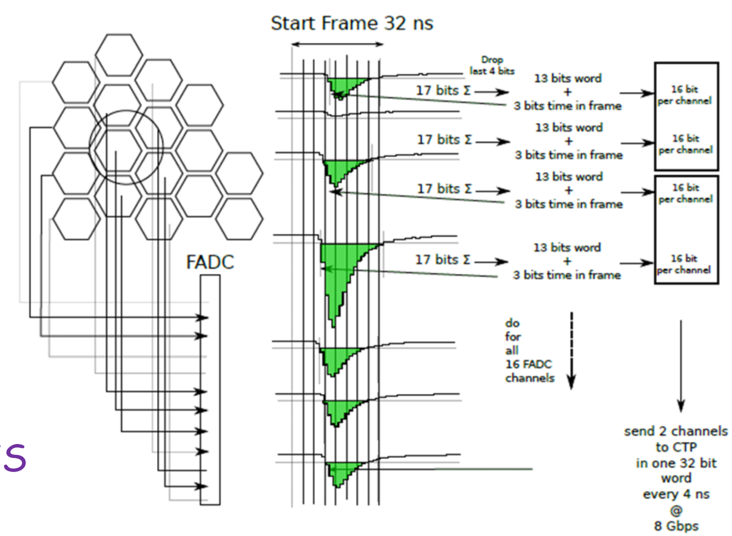
→ Estimation based on sophesticated Geant simulation and well-tone physics models
→ PVDIS: LGC+EC provide electron triggers, 27 KHz/sector, 30 sectors
→ SIDIS: Coincident trigger between electrons and hardrons within a 30 ns window:

LASPD+LAEC provide electron triggers, 25 KHz
LGC+FASPD+MRPC+FAEC provide electron trigger, 129 KHz
FASPD+MRPC+FAEC provide hardron trigger, 14 MHz

66 KHz + 6 KHz (eDIS)

◆ Read-Out and Data Aquisition System:

→ Use fast electronics to handle the high rates (FADC, APV25, VETROC, etc.)
→ Read out EC clusters to reduce background
→ Current design can take the trigger rates
60 KHz per sector for PVDIS, and 100 KHz overall for SIDIS
→ Use Level-3 to further reduce the events size
→ Learn new developments from others (e.g. Hall-D)



EC Trigger